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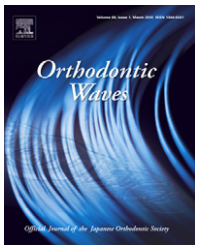

Research paper

Relationship between occlusal curvatures and bite force in humans

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ABSTRACT

Purpose: It is clinically believed that humans with a broad and rounded dental arch accompanied by a shallow curve of Spee have good masticatory function. However, the relationship between them has not been elucidated fully. The purpose of this study was to quantitatively examine the relationship between occlusal curvatures and bite force.

Materials and methods: Bite force was measured and analyzed in 20 young adults with healthy permanent dentition and normal stomatognathic function using a bite force recording system. Study models of the mandibular dental arch were scanned with CCD cameras, and X, Y and Z coordinates of the cusp tips of the molars were recorded. Their occlusal curvatures were analyzed using a three-dimensional measurement system.

Results: Bite force showed significant positive correlations ($0.52 < R < 0.57$) with the radius of the anteroposterior occlusal arc of the molar region and the radii of the translateral occlusal arcs in the second premolar, first molar and second molar regions, and showed significant positive correlation ($R = 0.71$) with the radius of the occlusal sphere of the molar region.

Conclusions: It was suggested that occlusal curvatures is related with the magnitude of bite force, and that the three dimensional spherical analysis of occlusal curvatures is useful predictor of the masticatory function.

1. Introduction

It is clinically believed that a broad and rounded dental arch is associated with the normal masticatory function [1]. A theory has been proposed that occlusal curvatures such as the curve of Spee is shallow in case of normal occlusion and become steep as overbite and overjet increase [2]. The three-dimensional arrangement of the occlusal surfaces has been called Monson's sphere. The radius of the sphere is explained to be 4 in. by the original observation [3]. However, few quantitative data have been proposed.

Several hypotheses about the functional significance of the occlusal curvature have been presented. It was speculated that occlusal curvatures have significance as a resistance against occlusal forces and for the stabilization of the dental arch during occlusion [4]. It was also speculated that occlusal curvatures are related to an increase in masticatory performance during

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chewing [5] and is related with protrusive movements of the mandible [6]. In the orthodontic treatment or prosthetic treatment, dentists are often aiming to arrange the dental arch with a shallow curve of Spee and adequately upright of molars, although there have been few studies have been proposed in which the relationship between occlusal curvatures and masticatory functions have been explained clearly in the clinical significance.

In order to quantify the functional properties of the masticatory system, various methods such as bite force measurement [7–12], masticatory performance [7,9,10,12], electromyographic activity of the masticatory muscle [7,10] and mandibular motion [7,11,12] have been reported. These methods showed significantly similar results [7–12]. Among the methods, bite force measurement using pressure-sensitive sheets is reported to be convenient and to have a high reproducibility and reliability [8]. It was suggested that bite force has an influence on the development of mastication [13–15].

Regarding the relationship between bite force and the dental arch, it has only been reported that bite force is related to the size of the maxilla and mandible [13,16,17] and the inclination of the molars [17]. There have been few studies proposed in which the relationship between occlusal curvatures and bite force has been examined. In addition, three dimensional characteristics of the dental arch could not have been analyzed by the conventional measurement.

The purpose of the current study was to examine the relationship of the occlusal curvatures with bite force with three dimensional analysis.

2. Materials and methods

2.1. *Materials*

Twenty male adults with permanent dentition were selected from 105 male students at Kagoshima University Dental School (age: 22–31 years old). Inclusion criteria were sound full permanent dentition including the second molars and normal stomatognathic function. Exclusion criteria were missing teeth, cast restorations or cuspal coverage, previous or current orthodontic treatment, temporomandibular disorders, gingivitis and periodontitis. All the subjects were informed of the experimental protocol and signed an informed consent. The subjects' rights were protected throughout the experimental procedures.

2.2. *Measurement protocol*

2.2.1. *Analysis of bite force*

We recorded the bite force when each subject performed maximal voluntary clenching on a 0.1 mm-thick pressure-sensitive sheet (Dental Prescale, 50H-R, Fuji Film Co., Tokyo,

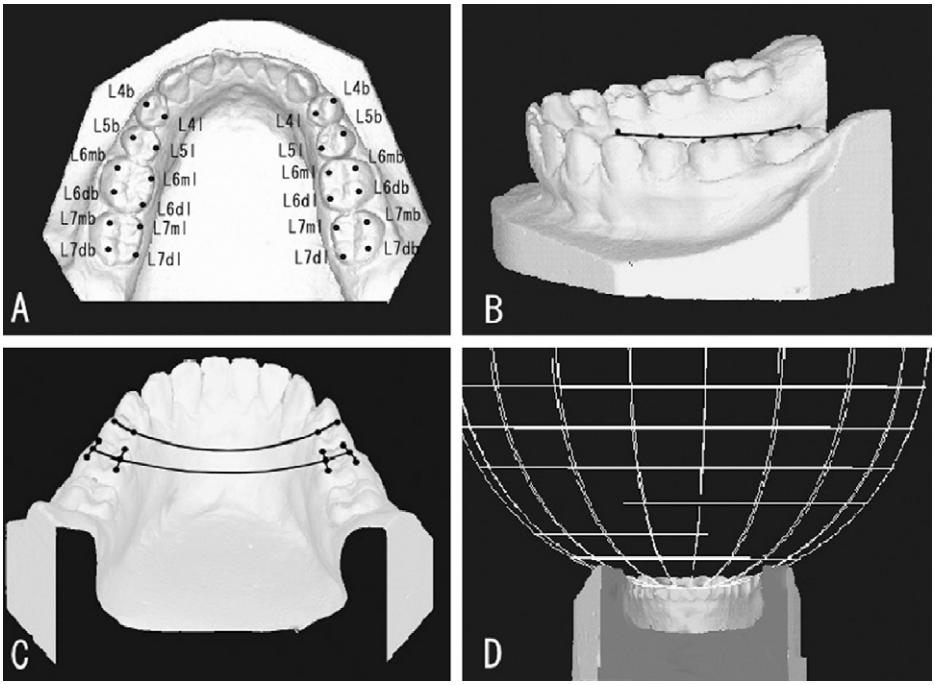

Fig. 1 – (A) Landmarks used for the analyses of occlusal curvatures. "b" means buccal, "l" means lingual, "ml" means mesial lingual, "mb" means mesial buccal, "dl" means distal lingual, and "db" means distal buccal. (B) Example of an anteroposterior occlusal arc of L4-7 on the left side is shown. (C) As examples of the translateral occlusal arcs, translateral occlusal arcs of L5-L5 and L6-L6 are shown. Translateral occlusal arc of L4-L4 was made out with buccal and lingual cusps in the same manner as translateral occlusal arcs of L5-L5 shown in the figure. Translateral occlusal arc of L7-L7 was made out with midpoints of mesial buccal cusp and distal buccal cusp, and midpoints of mesial lingual cusp and distal lingual cusp in the same manner as translateral occlusal arcs of L6-L6 shown in the figure. (D) An example of an occlusal sphere of L4*4-7*7 set up with all the landmarks.